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MORE GOOD WATER

..research at San Dimas Experimental Forest applying fundamentals to entire watersheds

By Walt Hopkins

Can southern California watersheds be managed to produce more water--without increasing flood and erosion hazards?

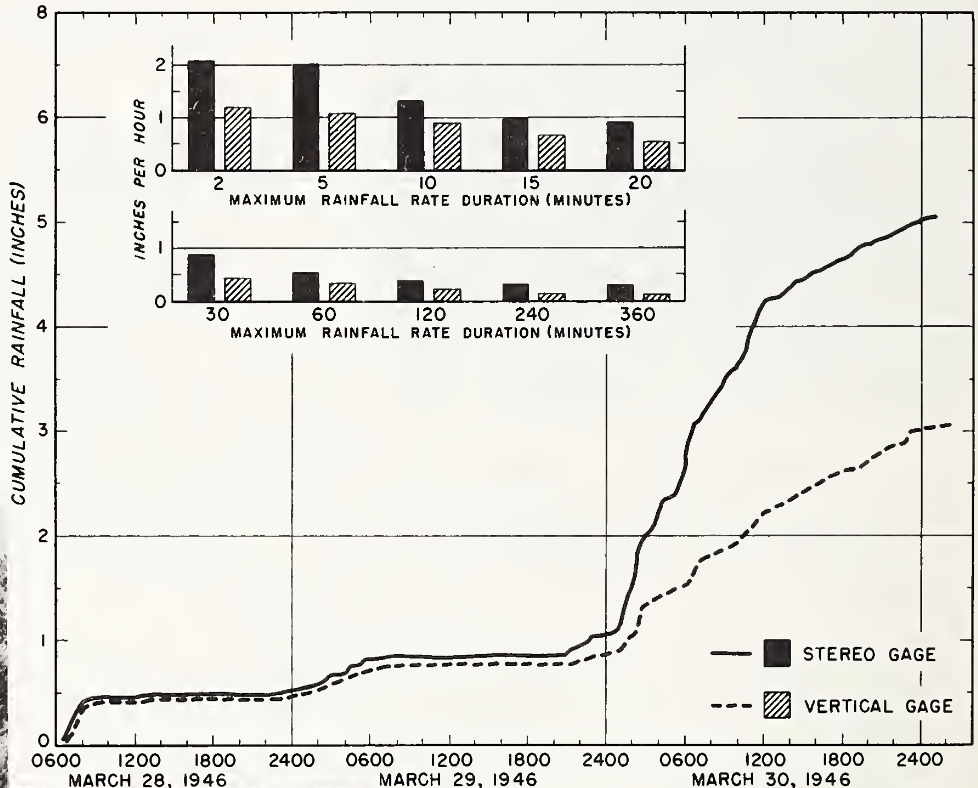
We have some of the answers. Basic studies in watershed management research were started at San Dimas Experimental Forest 25 years ago. We have learned how to measure rainfall accurately in chaparral-covered mountains. We know that chaparral plants differ in rates of water use. We are learning how soil moisture and surface runoff are influenced by different kinds of cover. And we can account for rainfall, moisture losses, streamflow, and ground water yields on entire watersheds. Through the years we have learned many of the fundamentals of how a watershed works.

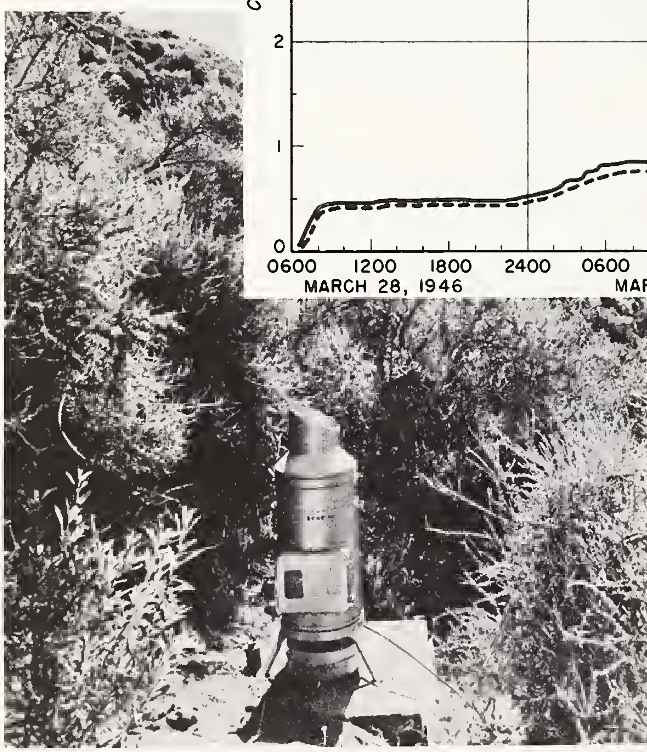
Now this fundamental knowledge is being applied on whole watersheds. We are asking "How much more good water can be produced by research-guided management?" The answers are needed as soon as possible. In spite of all the water imported to southern California, 60 percent of the water used in the South Coastal Basin comes from local watersheds. Local water of high quality will always be in demand.

Rainfall Measurements

One of our first jobs was to get the rainfall story. When does it rain? How much? How hard? Early in the game we found that conventional, vertical raingages gave us inaccurate rainfall measurements. They were especially inaccurate during high intensity storms when accurate measurements were most needed. After testing raingages of many sizes and shapes we found that if the receiving rim of the gage is parallel to the mountain slope upon which the gage is placed, our rainfall measurements were much more accurate. We call these tilted or "stereo" raingages. At one time we had more than 300 raingages on the experimental forest. Today we are getting reliable measurements using only 17 properly designed gages.

Note how stereo and vertical raingage measurements varied as rainfall intensity increased.





A stereo recording raingage.

The San Dimas Lysimeters

What happens to the rainfall once it reaches the watershed? How well do brush and other plants serve as watershed cover? How does runoff differ, say, under pine or grass cover? Does infiltration and percolation of water through the soil vary under different native chaparral species? Do some of these plants use more water? In 1937, to answer such questions, the now world-famous San Dimas lysimeters were constructed. Ceanothus, buckwheat, chamise, scrub oak, Coulter pine and grass are growing on these 10.5 x 21.8 x 6 feet concrete tanks, and one tank has been kept bare. Electrical instruments transmit and record water levels and thus help us measure rainfall, runoff, and seepage. Colman electric soil-moisture units make it possible to measure water movement into and through the soil and evaporative losses from the soil.

As you might expect, the bare lysimeter has produced the most runoff. Infiltration under the grass, shrubs, and pine has been more than twice that of the bare lysimeter. All available soil moisture under the shrubs and pine has been lost to evaporation and transpiration. Only under the grass has a water yield through seepage occurred.

Disposition of average annual rainfall,[1] San Dimas lysimeters

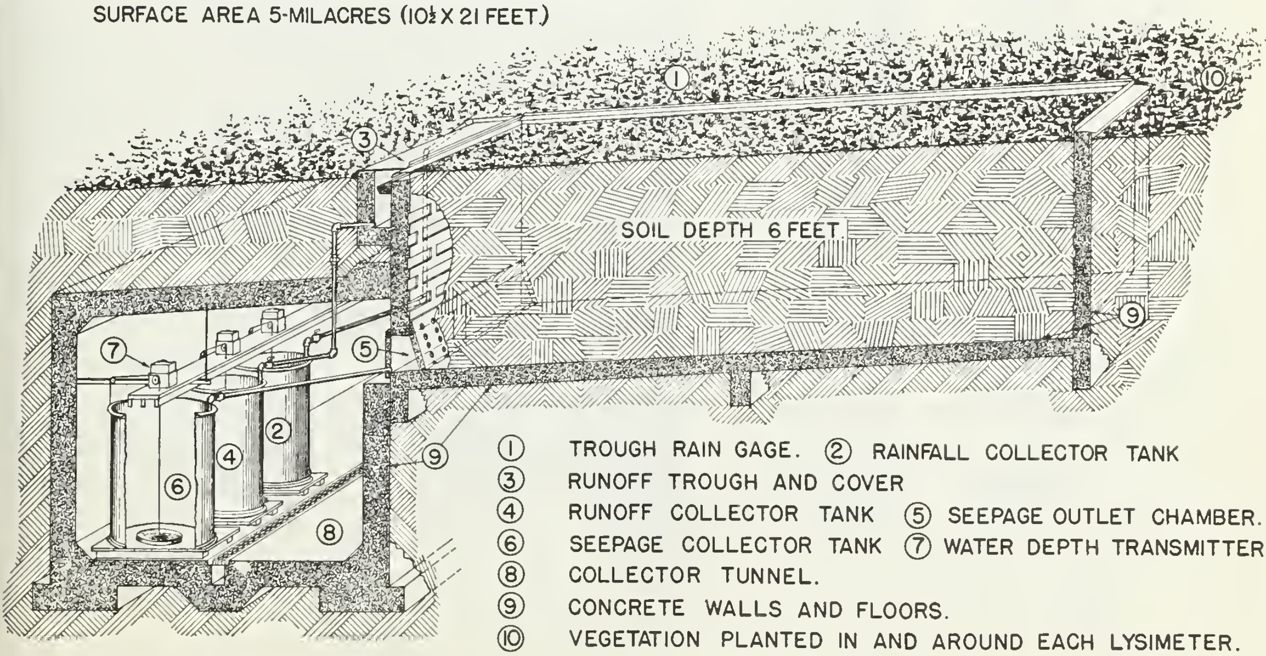
Vegetation	Surface runoff	Infiltration	Seepage	Loss[2]
	------Inches depth---------			
Bare	13.0	7.7	0	7.1
Pine	5.6	15.1	0	15.1
Chamise	4.1	16.6	0	16.5
Grass	4.0	16.7	1.7	15.3
Buckwheat	3.5	17.2	0	17.2
Scrub Oak	3.3	17.4	0	17.5

1/ Average = 20.7 inches (October 1, 1952-September 30, 1956); range, from 16.01 to 25.39 inches.

2/ Loss = Rainfall-(runoff + seepage - increase or + decrease in soil moisture storage during period). Includes evaporation from soil, transpiration, and interception loss.

DIAGRAM OF A SINGLE LARGE LYSIMETER

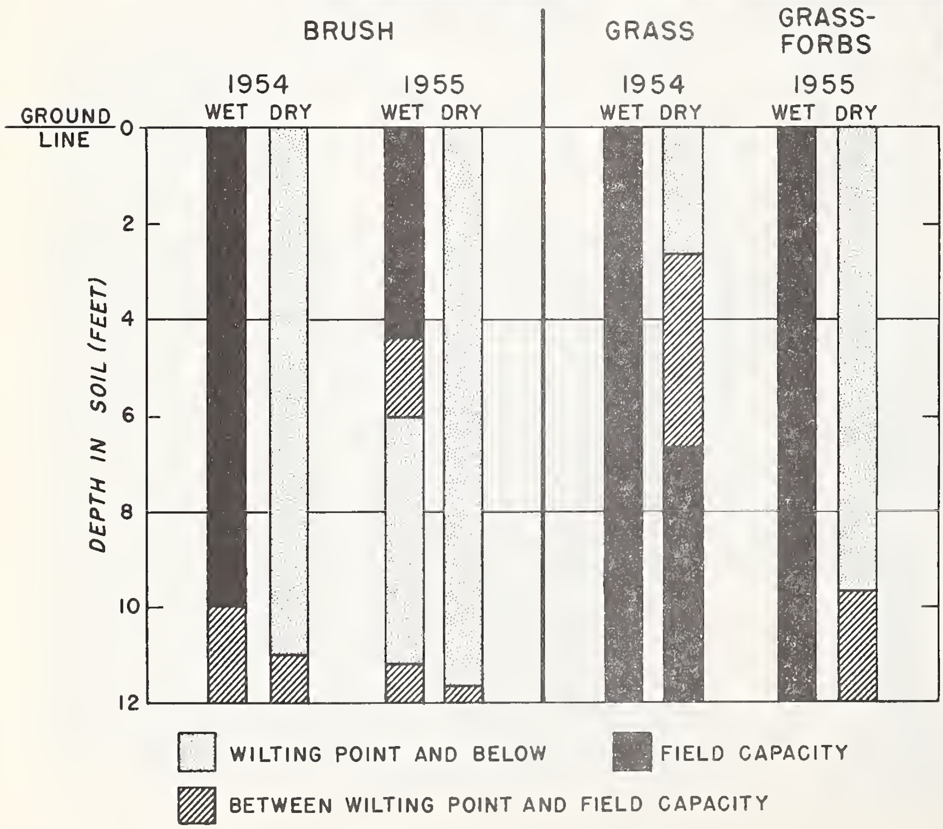
SURFACE AREA 5-MILACRES (10½ X 21 FEET)



Soil Moisture-Runoff Plots

Can we get a greater yield of usable water by replacing chaparral with a grass cover? For several years we measured runoff, erosion, and soil-moisture percolation on 9 hillside plots heavily covered with native brush--mostly scrub oak. These plots are on unusually deep soil, averaging about 12 feet. In 1951, we cleared 6 brush plots, planted them to annual rye grass, and compared evaporation and transpiration losses.

Soil Moisture-Runoff Plots. Cover on half the area has been converted from brush to grass.



Soil-moisture differences under brush, grass, and grass-forb cover.

In brief, the story is this. During a winter of average rainfall, the soils under both brush and grass were wet to field capacity. Then, during the long dry season, evaporation and transpiration dried the brush-covered soils to depths of 11 feet and more. At the same time, a substantial soil-moisture saving and potential ground water yield was obtained under the grass cover. But as soon as we permitted weeds to invade the grass-covered plots, we lost our soil-moisture gains.

This study has pointed up two very important considerations. (1) When we convert from brush to grass, we must maintain the site in grass alone or soil-moisture savings will be dissipated by deep-rooted weeds and shrubs. (2) Soil moisture savings were obtained only at depths greater than 3 feet. Thus, evaporation and transpiration will use all available moisture on shallow sites regardless of the kind of plant cover.

Calibrating the Performance of Whole Watersheds

In 1934, we started keeping detailed records of rainfall and streamflow for 17 entire watersheds on the San Dimas. For most of them we have rather complete pictures of their hydrologic characteristics, and we now can predict the performance of one watershed by measuring the performance of another. Companion studies have shown us that on the average over half of the annual rainfall is lost through evaporation and transpiration. So, there is plenty of room for improvement as we search for ways to manage these watersheds for increased water yield.

ANNUAL RAINFALL DISPOSITION
MONROE CANYON
1938-39 to 1952-53

		15-Yr. Average
RAINFALL, inches		27
Interception Loss	3	
Evapo-transpiration	12	
TOTAL LOSS, inches		15
Streamflow yield	3	
Ground water yield	9	
TOTAL YIELD, inches		12

Managing the Watershed

Now, we are embarking on studies that we have been anxious to tackle for years--to apply the basic knowledge we and others have developed, and place whole watersheds under intensive management. Our objective is to increase the yield of usable water.

Can we increase water yield by removing the thirsty riparian and associated woodland growth along stream channels? By replacing the brush with grass on slopes with deep soil? How much water can we save? When will the water yield be delivered? Just how will these measures affect floods and sedimentation?

During the winter of 1957-58, in cooperation with the California Division of Forestry, the Los Angeles County Fire Department, and the Angeles National Forest, we started removing the riparian-woodland growth in Monroe Canyon (an 875-acre watershed). In April 1958, chaparral will be deadened on side slopes with deep soils in Bell Watershed No. 2. The objective in each watershed is to increase the water yield. Two comparable watersheds will be maintained in their natural condition as checks.

Research workers are concentrating their studies of rainfall, streamflow, soil moisture and vegetation in these managed and check watersheds.

Can southern California's watersheds be managed for more water on a practical basis? This step in the San Dimas research program will provide many of the answers.